

AMENDMENTS TO THE CLAIMS

Listing of claims:

This listing of claims replaces all prior versions and listings of claims in the application.

Claim 1 (Currently Amended): A distance image sensor for projecting light from a light source to an object intermittently and measuring the distance by the delay time of the reflected light thereof, comprising:

a photo-detector (PD) having a photo-diode structure buried in a semiconductor substrate for converting reflected light from an object into charges;

a plurality of gate means (G1, G2) having an MOS (Metal Oxide Semiconductor) structure on a semiconductor substrate;

a plurality of charge storage nodes (C1, C2); and

control means (6) for controlling the switching of said gate means, ~~characterized in that~~

wherein

[[to]] at least two of said charge storage nodes, that is a first charge storage node and a second charge storage node, charges from said photo-detector are alternately transferred and stored, synchronizing the light intermittent operation from said light source, by said gate means, that is a first gate means and a second gate means, so that the charge transfer efficiency from said photo-detector is improved and the distance to the object is determined using the distribution ratio of the stored charges.

Claim 2 (Currently Amended): The distance image sensor according to Claim 1, further comprising a third gate (G3) means in a third charge storage node (C3), ~~characterized in that~~ wherein when reflected light by projected light does not exist, charges by background light are transferred to said third charge storage node by opening said third gate means, so that the charges are stored in said third charge storage node for removing background light.

Claim 3 (Previously Presented): The distance image sensor according to Claim 1, further comprising sampling & hold means corresponding to each of said charge storage nodes.

Claim 4 (Currently Amended): A distance image sensor for projecting light from a light source to an object intermittently and measuring the distance by the delay time of the reflected light thereof, comprising:

a photo-detector for converting reflected light from an object into charges;
an inversion amplifier to which signal charges from said photo-detector are input;
a first serial circuit further comprising a first capacitor (C1) and first switching means (ϕ_1) connected to said first capacitor in series;
a second serial circuit further comprising a second capacitor (C2) and second switching means (ϕ_2) connected to said second capacitor in series; and
control means (6) for controlling the switching of said first and second switching means,
~~characterized in that~~ wherein

said first serial circuit is connected between the output and the input of said inversion amplifier, and said second serial circuit is connected between the output and the input of said inversion amplifier to construct a negative feedback amplifier, signal charges which depend on the delay time of the reflected light from an object are distributed to said first capacitor and said second capacitor by switching of said first and second switching means, so that the charge transfer efficiency from said photo-detector is improved and information on distance to the object is acquired from the charges stored in said first and second capacitors.

Claim 5 (Currently Amended): The distance image sensor according to Claim 4, further comprising a third serial circuit which comprises a third capacitor (C3) and third switching means (ϕ_3) connected to said third capacitor in series, ~~characterized in that~~wherein charges by background light are transferred to said third capacitor by closing said third switching means when the reflected light by the projected light does not exist, so that the charges are stored in said third capacitor for removing the background light.

Claim 6 (Currently Amended): A distance image sensor for projecting light from a light source to an object intermittently and measuring the distance by the delay time of the reflected light thereof, comprising:

a photo-detector for converting reflected light from an object into charges;
an inversion amplifier to which signal charges from said photo-detector are input;

a first serial circuit further comprising a first capacitor (C1) and first switching means (ϕ1) connected to said first capacitor in series;

a second serial circuit further comprising a second capacitor (C2) and second switching means (ϕ2) connected to said second capacitor in series;

control means (6) for controlling the switching of said first and second switching means,
wherein

said first serial circuit is connected between the output and the input of said inversion amplifier, and said second serial circuit is connected between the output and the input of said inversion amplifier to construct a negative feedback amplifier, signal charges which depend on the delay time of the reflected light from an object are distributed to said first capacitor and said second capacitor by switching of said first and second switching means, so that the charge transfer efficiency from said photo-detector is improved and information on distance to the object is acquired from the charges stored in said first and second capacitors and

~~The distance image sensor according to Claim 4, further comprising n (n = 2 or 3) number of gates and n number of capacitors for holding, characterized in that wherein the r (r = 1, 2, . . . n)-th capacitor for holding is connected to the output of said inversion amplifier via the r-th gate, the charges stored in said r-th capacitor are transferred to said r-th capacitor for holding by opening said r-th gate corresponding to the closing of said r-th switching means, and sampling & holding operation of charges is performed, so that calculation is enabled for all the pixels simultaneously.~~

Claim 7 (Currently Amended): The distance image sensor according to Claim 1, characterized in thatwherein a brightness image signal is acquired from the sum of the charges stored in said first and second capacitors or storage nodes, the sum of charges stored in said first to third capacitors or storage nodes, or charges stored in said third capacitor or storage node.

Claim 8 (Currently Amended): A distance image sensor for projecting light from a light source to an object intermittently and measuring the distance by the delay time of the reflected light thereof, comprising:

a photo-detector (PD) having a photo-diode structure buried in a semiconductor substrate for converting reflected light from an object into charges;

a plurality of gate means (G1, G2) having an MOS (Metal Oxide Semiconductor) structure on a semiconductor substrate;

a plurality of charge storage nodes (C1, C2);

control means (6) for controlling the switching of said gate means, wherein at least two of said charge storage nodes, that is a first charge storage node and a second charge storage node, charges from said photo-detector are alternately transferred and stored, synchronizing the light intermittent operation from said light source, by said gate means, that is a first gate means and a second gate means, so that the charge transfer efficiency from said photo-detector is improved and the distance to the object is determined using the distribution ratio of the stored charges and

~~The distance image sensor according to Claim 1, further comprising voltage control delay means for passing signals for controlling the switching of said first and second gate means~~

or switching means, ~~characterized in that~~wherein a signal based on the difference of the charges stored in said storage node or capacitor is supplied to said voltage control delay means as a control signal with polarity where said difference of charges approaches zero, so as to form a negative feedback loop.

Claim 9 (Currently Amended): The distance image sensor according to Claim 1, ~~characterized in that~~wherein the pulse width for receiving the projection light, that is the period when said gate is open, or the period when said switching means is closed, is sufficiently short with respect to the repeat cycle.

Claim 10 (Original): The distance image sensor according to Claim 9, comprising reset means for clearing the charges by the background light synchronizing each cycle of the repeat cycle of the projection light.

Claim 11 (Currently Amended): The distance image sensor according to Claim 1, ~~characterized in that~~wherein said control means controls said gate means or switching means so that the charges at the moment when the reflected light rises are stored in said first charge storage node or capacitor, and charges after reflected light is at a stable level are stored in said second charge storage node or capacitor.

Claim 12 (Currently Amended): The distance image sensor according to Claim 4, ~~characterized in that~~wherein a brightness image signal is acquired from the sum of the charges

stored in said first and second capacitors or storage nodes, the sum of charges stored in said first to third capacitors or storage nodes, or charges stored in said third capacitor or storage node.

Claim 13 (Currently Amended): A distance image sensor for projecting light from a light source to an object intermittently and measuring the distance by the delay time of the reflected light thereof, comprising:

a photo-detector for converting reflected light from an object into charges;
an inversion amplifier to which signal charges from said photo-detector are input;
a first serial circuit further comprising a first capacitor (C1) and first switching means
(ϕ1) connected to said first capacitor in series;
a second serial circuit further comprising a second capacitor (C2) and second switching
means (ϕ2) connected to said second capacitor in series;
control means (6) for controlling the switching of said first and second switching means,
wherein

said first serial circuit is connected between the output and the input of said inversion amplifier, and said second serial circuit is connected between the output and the input of said inversion amplifier to construct a negative feedback amplifier, signal charges which depend on the delay time of the reflected light from an object are distributed to said first capacitor and said second capacitor by switching of said first and second switching means, so that the charge transfer efficiency from said photo-detector is improved and information on distance to the object is acquired from the charges stored in said first and second capacitors and

~~The distance image sensor according to Claim 4, further comprising voltage control delay means for passing signals for controlling the switching of said first and second gate means or switching means, characterized in that wherein~~ a signal based on the difference of the charges stored in said storage node or capacitor is supplied to said voltage control delay means as a control signal with polarity where said difference of charges approaches zero, so as to form a negative feedback loop.

Claim 14 (Currently Amended): The distance image sensor according to Claim 4, ~~characterized in that wherein~~ the pulse width for receiving the projection light, that is the period when said gate is open, or the period when said switching means is closed, is sufficiently short with respect to the repeat cycle.

Claim 15 (Previously Presented): The distance image sensor according to Claim 14, comprising reset means for clearing the charges by the background light synchronizing each cycle of the repeat cycle of the projection light.

Claim 16 (Currently Amended): The distance image sensor according to Claim 4, ~~characterized in that wherein~~ said control means controls said gate means or switching means so that the charges at the moment when the reflected light rises are stored in said first charge storage node or capacitor, and charges after reflected light is at a stable level are stored in said second charge storage node or capacitor.